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A COMPARATIVE ANALYSIS OF THE FIGHTER AIRCRAFT ACQUISITION PROC--ETC(U)
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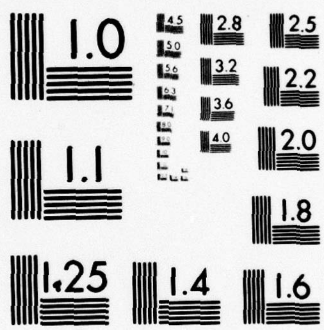

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AIR FORCE SECTION

U.S. ARMY COMMAND AND GENERAL STAFF COLLEGE

DEPARTMENT OF THE AIR FORCE

MCMXLVII

UNITED STATES OF AMERICA

A RESEARCH STUDY SUBMITTED TO THE AIR FORCE FACULTY

May 1979

FORT LEAVENWORTH, KANSAS

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Analysis of particulars of how U.S. acquires fighter aircraft and the process used. Procedures on how Soviet acquisition proceeds is contrasted with US. procedures.

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AIR FORCE SECTION

U.S. ARMY COMMAND AND GENERAL STAFF COLLEGE

6 A COMPARATIVE ANALYSIS OF THE FIGHTER AIRCRAFT
ACQUISITION PROCESS IN THE UNITED STATES AND
THE SOVIET UNION.

By

10 Harry J. Kieling, Jr., Major, USAF

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9 RESEARCH STUDY, SUBMITTED TO THE AIR FORCE FACULTY

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INTRODUCTION

"For more than a decade the Soviets have produced more weapons, in greater variety, than the United States."[1] Estimating the exact quantitative, much less qualitative, difference is difficult and subject to controversy. A recent CIA study stated Soviet defense costs exceeded U.S. outlays by over ten percent and equalled in constant 1978 dollars about $145 billion. In military investment alone the Soviets exceeded the U.S. by an estimated 65 percent in 1978.[2] The purpose of this paper is to compare one aspect of this defense spending--the aircraft acquisition cycle.

Section I will outline the current U.S. approach to research and procurement of a major weapon system. Included in this section will be a discussion of two specific and relatively new features of the U.S. system--fly-before-buy and the program manager concept. Section II deals with the Soviet system. The third and concluding section is the author's personal view on the more obvious and critical shortcomings of the two systems.

SECTION I

THE U.S. AIRCRAFT ACQUISITION PROCESS

The Department of Defense aircraft acquisition cycle in its basic format is diagrammed in figure 1 on page ___ The first of the five classical stages in the acquisition process is the conceptual phase. Perception of the threat is the catalyst for the entire process. Once the threat has been defined, alternative ways to meet the threat are determined. Provisional systems are presented and a preferred solution established. Simultaneously, performance standards and concepts are defined. Prime service customers are identified and interested contractors and consulting firms are contacted. Funds for this conceptual phase are provided by Congress from Research, Development, Test and Evaluation (RDT&E) appropriations. Generally, the conceptual phase will cover exploratory and advanced development and experimental prototypes.[3]

The product of this stage is a viable program concept. With completion of this concept (in our case a new aircraft design) the conceptual phase ends with a decision by the Defense System Acquisition Review Council (DSARC). The DSARC is an "advisory body of the Secretary of Defense on major system acquisitions. The council members are the OSD staff principals."[4]

Looking again at figure one, one sees there are three DSARC decision points. Each of these is critically important. With a negative decision at any of these points the program is finished. At the end of the conceptual phase the DSARC I, or "program decision" is made.[5] It is ultimately decided by the SECDEF,

based mainly on his evaluation of the recommendations of the DSARC. This decision is based on the program effectiveness, cost, and its integration into the overall projected defense posture.

Based on a favorable decision to continue development at DSARC I, the new aircraft idea moves into the validation phase. This phase involves verification of preliminary design and engineering, solicitation and evaluation of specific proposals for engineering development, and selection of a development contractor or contractors. Essentially the objective is "to provide a basis for determining whether or not to proceed into full-scale development."[6] Advanced prototyping efforts are done to confirm feasibility of technology, military utility, and adequate reduction of risk. Cost and development schedule estimates are developed for full scale development. At DSARC II, the decision to advance to the third major stage is again made by the Office of the Secretary of Defense.

The third major segment of the cycle is entitled full-scale development. It is at this point the weapon system as a whole, including support equipment is engineered, constructed and tested. "The objective of this process is to provide sufficient information for a decision to initiate production of the system."[7] Near production prototypes are delivered and tested to determine final design. Tradeoffs between stated operational requirements and other variables like cost, technical feasibility, and delivery dates are worked out. Most of the research and development outlays take place during the full-scale development phase.[8]

It is essential that continuous and critical reviews be made of the program as it develops. This is particularly true before arriving at a decision to go into full-scale development. In recent years, begininning with Secretary McNamara, this system of reviews has become more and more formalized.

The fourth stage of the acquisition process is the <u>production phase</u>. It is here the majority of funds are committed.[9] In this facet of the cycle the production contract is agreed upon. The total system, including spares, facilities, and training equipment is produced. This phase also includes production, service, and user testing. An attempt is made to schedule financial commitments so that they are minimized initially until major engineering or development problems, if any, are resolved. If the acquisition process has functioned ideally, these developmental problems will have been resolved during previous phases. But, invariably, some technical or engineering problems, however minor, will creep into the process unannounced at any stage.

When the classical production phase is complete the weapon system is turned over to the using command, which begins the last of the five stages--<u>the deployment phase</u>. This is when the operational units are trained, and necessary logistical support is supplied along with the equipment. Normally in the Air Force process, it is during the deployment phase that the weapon system is transferred from Air Force Systems Command to Air Force Logistics Command.

FLY-BEFORE-BUY AND COMPETITIVE PROTOTYPING

In defense jargon, fly-before-buy has become a household word.

Prior to fly-before-buy we had McNamara's Total Package Procurement Concept (TPPC). This program had all anticipated development, production, and support procured in one total package with a single contract with price and performance specifications at the onset. This envisioned a single major authorization decision being made.[10] When compared to fly-before-buy, one major difference with TPPC was that the former program had highly concurrent production initiated long before development was completed.

Senator John L. McClellan once remarked that this procurement process which was responsible for the F-111 was "a fiscal blunder of the greatest magnitude" which wasted more than 500 million dollars, impacted adversely on U.S. defense posture, and lowered public confidence in the defense establishment of this country.[11] The F-111 was embodiment of TPPC, and as evidenced by the quote above, not a very efficient procurement policy. One often cited shortcoming which was inherent in the philosophy of concurrent development was an over reliance on "paper designs." This concept often led to severe technical problems, high cost overruns, and in some cases program cancellation.[12]

This less than successful acquisition management system was replaced in 1970 by a competitive prototyping concept, commonly known now as fly-before-buy. In creating this system, Mr David Packard believed the DOD should put more emphasis on hardware and testing than on "paper studies".[13] Fly-before-buy represents a cautious approach at providing the United States with quality defense systems at the lowest cost.[14]

In 1972, the U.S. Air Force initiated two advanced prototype aircraft projects under this program--the Lightweight Fighter (LWF)

and the Advanced Medium Short Takeoff and Landing Transport (AMST(. The AMST has since encountered congressional budgeting problems, but the LWF has resulted in the very promising F-16 aircraft.

In essence, fly-before-buy is designed to control cost growth by early identification of impending design problems and reduction of technical risk by requiring demonstrated performance before committing production dollars. In this light, fly-before-buy has been successful. However, one significant criticism of the program--increased development time--will be examined in Section III.

THE PROGRAM MANAGER

Another relatively recent innovation in the U.S. weapon acquisition process is the introduction of the program manager concept. Actually, this broad concept cannot be considered entirely new because similar "projects" approaches were used in World War II and the 1950s with various missile endeavors.[15] However, recent iterations of this program manager idea place renewed emphasis on a centralized authority entirely responsible for the project. The program manager is really the commanding officer of his program and he is tasked with formulating and executing his budget within the approved limit. He also must forecast his long range needs and entire life cycle requirements. He is the focal point and he maintains an overall persepective on the entire program.

When it comes to the key program decisions made at the DSARC phase points, it is generally the program manager who defends his project. The high level decisions made by the DSARC often "hinge on the effective, impressive and knowledgeable presentation by the program manager."[16] Certainly this centralization of

responsibility follows traditional management concepts, but oftentimes the program manager is not given authority commensurate with the responsibility. Successful program managers frequently are those who understand the system and don't hesitate "to interpret rules and regulations in a way that will expedite their work."[17]

The program manager is often put in the unenviable position of having to decide what new "nice to have additions" he can incorporate into his project and what must be foregone in order to keep costs down and performance within constaints.

The program manager process has resulted in overall improvement of of the total acquisition process. The success of this innovative management concept is due in large part to the caliber of individuals selected for these responsible positions. Some of the other initiatives undertaken to further strengthen this program are: (1) carefully selecting individuals with demonstrated ability to get things done; (2) training and indoctrinating candidates at the newly created Defense Weapon System Management Center; (3) and leaving designated individuals in their jobs long enough to see their projects through to completion.

FIGURE 1

1. Threat Assessment
2. Mission Need - specific service selected
3. Research and Technology Base
   a. Technological Feasibility
   b. Milestone 0
4. Conceptual Phase
   a. DSARC I
5. Validation Phase
   a. DSARC II
6. Full Scale Development
   a. Prototype Developed
   b. Contract Definition
   c. DSARC III
7. Production
8. Retrofits
9 Deployment and Support

NOTES FOR SECTION I

[1]Robert Perry, Comparison of Soviet and U.S. Technology, R-827-PR (Santa Monica: RAND Corporation, 1973), p.3.

[2]Department of the Army, "A Dollar Cost Comparison of Soviet and U.S. Defense Activities, 1968-1978," Intelligence Summary, January 26, 1979, pp. 1-2.

[3]Sacramento Air Logistics Center, Acquisition Management Handbook (Sacramento: Directorate of Materiel Management), p. I-3.

[4]Department of Defense, "Major System Acquisitions," DOD Directive 5000.1, January 18,1977, Encl. 1.

[5]Sacramento Air Logistics Center, Acquisition Management Handbook, p. I-3.

[6]Lincoln Landis and Kendall W. Simmons, Science, Technology, Research and Development (Washington, D.C.: National Defense University, 1977), p. 115.

[7]Ibid.

[8]SALC, Acquisition Handbook, p. I-4.

[9]Ibid.

[10]Thomas C. Germscheid, Lt Col, USAF, "Is Fly-Before-Buy Here to Stay?" (Research Report: U.S. Army War College, 1973), p.1.

[11]Ibid., p.20.

[12]Ibid., p.2.

[13]Clarence A Patnode, Lt Col, USA, "Problems of Managing Competitive Prototyping Programs" (Study Report:Defense Systems Management School, 1973), p. 2.

[14]Germscheid, _Fly-Before-Buy_, p. 35.

[15]Landis, _Science, Technology, and R & D_, p.119.

[16]Terry Edward Magee, "Differences in Aircraft Acquisition Management Practices Between the Air Force and the Navy" (Thesis: Naval Postgraduate School, 1977), p. 62.

[17]Landis, _Science, Technology, and R&D_, p. 120.

[18]Magee, "Differences in Aircraft Acquisition Management,"p.13.

SECTION II

THE SOVIET PROCESS OF DESIGN, PROCUREMENT, AND PRODUCTION

Within the Soviet Union the centralized authority for aviation matters is focused in the Ministry of Aviation Industry (MAP). This Ministry guides virtually all research, design, development, and manufacturing functions. The Ministry also produces those materials and products essential to the manufacture of aircraft. Despite this centralization the various sub-functions are performed by essentially administratively separate organizations.

The sequence of steps generally seen in the Soviet acquisition process follows. First, a proposal for a new aircraft is put forward by either the potential users or by the designers within the aviation ministry itself. These proposals almost invariably stress evolutionary rather than revolutionary design.

The aviation ministry may finance experimental development if there is as yet no potential buyer for the proposed finished product. However, these ministry financed experimental designs rarely go far without a potential customer. This is due to a rather limited experimental budget for the ministry.[1] As is the case in the United States, requirements pull technology is much more popular than the technology push brand.

The second step in the process occurs when the proposal is submitted to the Council of Ministers. The Council provides the overall direction requisite of the tight control and centralized planning inherent in the Soviet economy. When the Council approves a proposal it is sent to one of the research institutes.

The Research Institute

Research institutes perform most of the preliminary research and also provide standards by which the aircraft industries and the design bureaus operate. The research institute is essentially and autonomous organization; and, efficient communications across functional boundaries are important.

One of the principal purposes of the research institute is to pass data to the next stage in the process--the design bureau. Usually these research findings are transmitted in a handbook for designers published primarily by The Central Aerohydrodynamics Institute (TsAGI), the oldest and most important aviation research institute in the Soviet Union.[3] The avowed purpose of this handbook is to keep design bureaus abreast of the latest research results plus constrain "designers to work within a common, proven, technical code."[4] This emphasis on use of these handbooks produces remarkable similarities in approach by different design bureaus. A British writer comments on the specific merit of the system: "As long as swept wings defy exact theoretical treatment and consequently require prolonged aerodynamic development by trial and error, there is much to be said for such an approach."[5]

The research institutes also provide information on approved lists of materials and manufacturing techniques. In reference to our hypothetical cast the TsAGI would likely provide specific advice and instructions on the project forwarded. These instructions would be in exact terms for the project at hand.

During this stage the research institute studies the request

and also gives broad direction to the project. Also at this time the Scientific Technical Commission accomplishes a critical review.

Scientific Technical Commission

The composition of this group is made up of members of the customer and production ministries. Generally they are drawn from senior staffs of research and user organizations.[6] The commission's task at this stage is to work out differences of opinion and develop the details and technical parameters of the project. The pre-project, as the proposal is called at this stage, is usually assigned to more than one design bureau for elaboration. This pre-project is detailed in a titled document which sets forth such guidance as purpose of the aircraft, performance characteristics, and other specifics.

The Scientific Technical Commission enters the process at several other key points. At various stages of development it reviews the project and offers advice. It also serves as a "source selection board."[7] How the different designs meet this decision point will be detailed later. The Commission does not muddle in the day to day operation of the design bureaus, but it does make strategic sequential decisions during the process. "The continuity of membership over the life of a project together with the prestige and competence of the members give the Commission's decisions an unusual degree of authority."[8] By exercising critical and periodic review the Commission functions like the DSARC.

The Design Bureau

In the USSR, the design bureau is center stage in the acquisition process.[9] Its basic purpose is design, development, and

construction of prototypes. This is where the principal engineering work is done.[10] The design bureaus themselves rely heavily on research facilities. As was mentioned earlier the research institutes provide handbooks and special instructions to the design bureau. One reason for this reliance is the lack of test and research facilities at the design bureau. "The research institutes have a monopoly on the largest wind tunnels, test rigs, and so on, as well as the most qualified scientists." [11] The design bureaus look to the research institutes for solution of problems that arise and day to day guidelines on design.

When the pre-project is forwarded from the Scientific Technical Commission to the design bureau a senior designer works out the general outlines of the aircraft based on the specifications. The design bureau, in fact, is often named after their chief designer. Well known names like Antonov, Mikoyan, Tupolev, Yakolev, and others, are linked to the design bureaus they head. These individuals are very influential within their own bureaus in determining what will be produced. These designers stake their reputation and perhaps their careers on the success or failure of their outputs. This designer is often given great responsibility and at the same time great latitude in matters that concern what should or should not be developed. Even after the design is turned over to the series production plant ultimate control of the design appears to rest in the hands of the chief designer.[12]

At this point in the process a group of highly experienced designers under direction of the chief designer develop a more detailed blueprint over a several month period. The designers

then present their completed pre-project to the Scientific Technical Commission for consideration. In the case of fighter aircraft the Commission will usually select two or more designs for continued development.[13]

As the detailed design begins production, engineers from the aircraft production plants are brought into the process. "They convert the preliminary drawings used for the construction of the prototype into production drawings suitable for plant use."[14]

Production of the Prototype

The work of the design bureau culminates in the construction of a prototype. The prototype itself is built by a special experimental plant under control of the design bureau. Although administered by the design bureau, the experimental plant may be physically located as a department of a large production plant.

Two very interesting points should be highlighted at this stage of the process. First, the Soviet test pilot who flies and evaluates the prototype or early production models has a notable impact on its development. "Pilots are said to take part in all discussions connected with a new design. The opinions of the pilots who fly the aircraft in routine operations are also actively sought."[15] The test pilot has been described as "the designer's best assistant in creating a new aircraft."[16] The second point of interest is that the Soviets have long employed a similar but possibly more efficient method of what was described in Section I as fly-before-buy.

Fly-Before-Buy

"The concept of competition has remained as a dominant

force in the (Soviet) aviation industry over the years."[17] This competition in fighter aircraft is usually carried through to the prototype stage. In fact, the ratio of prototypes to production articles generally runs two to one in recent years.[18] The historical design practices of simplicity, commonality, and inheritance stem in part from this competition.

Time responsiveness also appears to bear heavily on the competition. Generally the aircraft "that flies first historically has had the best chance of winning the competition."[19] In turn, an aircraft that follows the tradition of simplicity and evolutionary design is likely to be the quickest off the line. This speedy design tradition appears to have historical roots. Stalin once remarked that the winner of design competition "will be the one who not only gives the best fighter in terms of flight and combat qualities, but also delivers first."[21] In fact, it often happened that the first aircraft to fly was chosen for production although a later competitive model had better characteristics.[22] The drive to get a prototype into the air quickly persists today even though many of the original motivating forces are no longer present.

In the Soviet Union no production decision is made until flight evaluation is complete. The result has been a broad spectrum of aircraft options from which they may choose the one most suited to the operational need after the system has been evaluated in flight test.

The Production Phase

For simplicity some further thoughts on prototype construction will be considered. These points will be combined with the production phase. In comparison with the special experimentation plant,

the series production plants are not specifically linked to one design bureau. However, there appear to be traditional bonds between a plant and a designer that extend over several decades.[22] It must be borne in mind that during production the designer still has a great deal of authority over the plant manager on manufacturing questions.

As the design work progresses, production engineers from the designated series plant are brought into the consultations. These individuals will advise on such matters as their plant capabilities and possible alternative approaches. At the same time these production engineers will become familiar with the design and prepare the production plans. When test flights are conducted on the prototype, changes required will be incorporated into the production design.

When the aircraft, together with the modified design, is finally transferred to the series production plant, engineers from the design bureau and the plant's manufacturing engineers who have been advising on the design transfer to the plant.[23] Throughout the production phase a design bureau representative will remain at the factory. In turn, the series plant will often send back suggestions for improvement to the design bureau.

NOTES FOR SECTION II

[1] Arthur J. Alexander, Weapons Acquisition in the Soviet Union, United States, and France, P-4989 (Santa Monica: RAND Corporation, 1973), p.5.

[2] Ibid.

[3] Ibid., p.3.

[4] Ibid.

[5] R.M. Braybrook, "Russian Blinder," Flying Review International, August 1964, p.30.

[6] Alexander, Weapons Acquisition, p.7.

[7] Ibid.

[8] Ibid.

[9] Arthur J. Alexander, R&D in Soviet Aviation, R-589-PR (Santa Monica: RAND Corporation, 1970), p.1.

[10] Robert Perry, Comparisons of Soviet and U.S. Technology, P-827-PR (Santa Monica: RAND Corporation, 1973), p.11.

[11] Alexander, Weapons Acquisition, p.3.

[12] Heather Campbell, Controversy in Soviet R&D: The Airship Case Study, R-1001-PR (Santa Monica: RAND Corporation, 1972), p. 4.

[13] Alexander, Weapons Acquisition, p.6.

[14] Ibid.

[15] Ibid., p.9.

[16] V.I. Tikhomirov, Organization and Planning of an Aircraft Construction Company, (Moscow:State Publishing House, 1957), p. 434.

[17] Alexander, Weapons Acquisition, p.7.

[18]Alexander, *Weapons Acquisition*, p.7.

[19]Ibid.

[20]A.S. Yakolev, *Target of Life* (Moscow:Tsel'Zhizni, Isdatel'stvo Politicheskoy Literatury, 1966), translated in Department of Commerce publication AD 674326., p.165.

[21]Alexander, *Weapons Acquisition*, p.10.

[22]Ibid., p.4.

[23]Ibid.

SECTION III

COMPARATIVE OBSERVATIONS ON THE TWO SYSTEMS

Comparisons of the two systems could be made and have been made on many different levels. I have chosen only two specific areas I feel are crucial: (1) the decision making bureaucracy, and (2) development time.

The Bureaucracy

Any understanding of the acquisition process of the two countries must confront the most basic assumptions of the root structure of the two governments and their relations with the aircraft industries.

The Soviet system fauningly patronizes their a sircraft industry. In the words of the Commander in Chief of the Soviet Air Forces: "Chairman Brezhnev personally (assures) the Air Force is constantly receiving the most up-to-date combat equipment."[1] For the Soviets, a steady stream of quality and quantity in military hardware is a beautifully bright light in an otherwise discouraging industrial effort. In the words of sovietologist Robert Perry: "despite a severely constrained economy and a much smaller industrial capacity, the Soviet Union is decidedly competitive with the U.S. in military R&D and the weaponry it generates."[2] Decidedly competitive may well have defined the Soviet state of the art when Mr. Perry published in 1973. Today, competitive is probably an understatement.

One universal aspect of any bureaucracy should be kept in mind even when examining a system as apparently autocratic as the Soviet one. Regardless of how highly placed, leaders in the USSR cannot make decisions nor degrees in a vacuum. They must depend on

bureaucracies to implement the policies.[3] One reason the Soviet weapons' production system is so prolific is there exists an almost symbiotic relationship between the politicians and the other elements of the process.[4]

The stability of leadership and continuity of decisions in the USSR contrasts sharply with the "revolving door" method of changing political leaders in the United States.[5] Stable leadership generally produces stable goals. Stable goals yield stable funding. For the Soviets, "stable funding insures ideas for new weapons will be generated and tested." Whereas 75% of all money expended on R&D in the USSR comes from stable fund sources; in the U.S., 75% is provided by some sort of annual appropriations.[6] In Mr. Arthur Alexander's words "stable budgets finance a steady stream of new weapons."[7]

One specific echelon of the Soviet bureaucracy which appears to have unique authority in the acquisition process and has undoubtedly made a significant contribution to the system's success is the design bureau chief. Men like Tupolev, Mikoyan, and Antonov have had a direct, personal, and continuing impact on aircraft models that are sponsored by their design bureaus and bear their name. The United States has produced no similar institutional personalism except possibly for the unique exception like C.L. (Kelly) Johnson's "skunkworks."[8] The program manager in the U.S. system has a personal impact on the development of the weapon system, but not on a scale approaching that of the design bureau chief. Another critical tier of the weapon buying bureaucracy is the high level groups who make sequential decisions on program continuation. In the U.S., this authority is delegated to the Secretary of Defense,

his undersecretaries, and the formally convened DSARC. In the USSR, it is the Council of Ministers and the Scientific Technical Commission. These groups in the Soviet Union are marked by their stability and tenure.[9] In the United States, tenure generally revolves around the results of frequent national elections. Mr. Alexander summarizes the basic theme of American culture as a diffuse decision making power where no single authority has final or dominating authority.[10]

Development Time

General Donn A. Starry, Commander, U.S. Army Training and Doctrine Command, stated the problem with development time very clearly:

> The development cycle (in the U.S.) is painfully slow. It's slow for several reasons-slow because in our country we insist on competition at every stage of developement as well as procurement. Because everything is in competition, any development requires virtually starting all over again from the beginning. We don't have a dovetailed product improvement program of the kind so characteristic of the Soviet system. We are slow because we have an enormous layering of bureaucracies-each one of which wants to rule on every stage of every developement to an excruciating degree of detail. A system like that can't function very efficiently.[11]

Undersecretary of Defense for Research and Engineering, William J. Perry, has estimated the time it takes to get an aircraft from full scale development to operational deployment is more than seven years. And it is getting worse. In the 1960s it averaged 4.5 years.[12] While it is not possible to precisely quantify the time required for a similar segment of the cycle in the Soviet Union, it would be

conservative to say it takes a lot less time. One of the reasons for this is the strong tendency in the Soviet Union for evolutionary rather than revolutionary design. This Soviet incrementalism does not necessarily produce an inferior product either. For when incrementalism, or evolutionary improvement, is maintained continuously and for a long time it can produce substantial changes.[13]

There are indications that the Soviets may also be more efficient in some aspects of the acquisition process. Mr. Robert Perry contends they seem to expend less in design manhours per pound of airframe and are building more prototypes. Their "development process requires about 40 percent fewer engineering manhours" than for a similar aircraft in the U.S.[14] It very well may be that in the U.S. "equity rather than efficiency is the dominant feature."[15]

When comparing the two systems solely from the standpoint of development time and institutional bureaucracy, the United States appears to be at a significant disadvantage. However, it can't be denied that systems approaches and economically attractive programs like fly-before-buy have recently produced some remarkable weapon systems like the F-15, A-10, and F-16.

In the final analysis, what is probably most ominous is whether the United States' system of buyer participation with its inherent "elaborate web of regulations"[16] is a buyer's luxury that can be afforded in the threat rich and unpredictable future. Certainly concurrent development, as practiced by TPPC in the 1960s, had its serious shortcomings. But, the disadvantages of concurrent development will have to continuously compared to the abnormally long

development time inherent in competitive prototyping, particularly as seen in the U.S. One of the toughest questions facing defense minded U.S. policy makers in the 1980s may well be whether our system of fighter acquisition with its long lead times, required accurate threat prediction, and demonstrated performance prior to production, can meet the weapon system output of the Soviet Union with its near omnipotent military-industrial complex, its patronizing bureaucracy, and its virtually sacrosanct aircraft industry.

NOTES FOR SECTION III

[1]P.S. Kutakhov, untitled interview, Voyennyy Vestnik (Military Herald) February 1978, p.32.

[2]Robert Perry, Comparisons of Soviet and U.S. Technology, P-827-PR (Santa Monica: RAND Corporation, 1973), p.3.

[3]Arthur J. Alexander, Decision Making in Soviet Weapons Procurement (London:The International Institute for Strategic Studies, 1978), p.41.

[4]Ibid., p.14.

[5]Lincoln Landis and Kendall W. Simmons, Science, Technology, Research and Development (Washington, D.C.: National Defense University, 1977), p.104.

[6]Perry, Comparisons, p.6.

[7]Alexander, Decision Making, p.33.

[8]Arthur J. Alexander, Weapons Acquisition in the Soviet Union, United States, and France, P-4989 (Santa Monica: RAND Corporation, 1973), p.19.

[9]Alexander, Decision Making, p.23.

[10]Alexander, Weapons Acquisition, p.19.

[11]Donn A. Starry, General, USA, "On Army Aviation," U.S. Army Aviation, November 1978, p.2.

[12]"Soviets Moving Fast in R&D, Hill Told," Air Force Times, 19 March 1979, p.20.

[13]Alexander, Decision Making, p.23.

[14]Perry, Comparisons, p.18

[15]Alexander, Weapons Acquisition, p.13.

[16]Ibid.

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